DOCUMENT RESUME

ED 254 965 EC 171 156

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TITLE Artificial Intelligence and Language Development and Language Usage with the Deaf.
PUB DATE 3 Aug 84
NOTE 14p.; Paper presented at the Conference on New Horizons in Deaf Education: Instructional Use of Microcomputers (Austin, TX, April 26-28, 1984).
PUB TYPE Speeches/Conference Papers (150) -- Guides - Non-Classroom Use (055) -- Information Analyses (070)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Artificial Intelligence; *Computer Assisted Instruction; Computers; *Deafness; *Language Acquisition

ABSTRACT

The paper reviews research on the application of artificial intelligence (AI) in language development and/or instruction with the deaf. Contributions of computer assisted instruction are noted, as are the problems resulting from over-dependence on a drill and practice format and from deaf students' difficulties in receiving and understanding new information. Examples are offered of approaches (such as Robert Ward's system) designed to promote syntax analysis of sentences. Projects are described which were designed to incorporate techniques of artificial intelligence in the area of language development; these include the ILIAD system, the JUMBLE approach, and the Word Expert Parser. Efforts in speech synthesis are also considered. Important elements in AI systems are reviewed, including the ability to provide on-level language instruction to the user with branching that would incorporate meaningful and appropriate instruction. An appendix offers an example of Robert Ward's system. (CL)

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Artificial Intelligence and Language Development and Language Usage with the Deaf

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August 3, 1983

Paper presented at the Conference on New Horizons in Deaf Education: Instructional Use of Microcomputers, Austin, TX

April 26-28, 1984

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"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
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Formal organized efforts to educate the deaf in our country have been established for more than one hundred and sixty years, but the results can not be considered very successful when the average deaf student graduates after 12 to 15 years of schooling with a fourth or fifth grade reading level. This is not to say they are not productive members of our community but their involvement and contributions are often limited. The area that education has tried to address in its efforts to change these reading scores is to concentrate on methods dealing with the acquisition and usage of language (See Appendix I for language samples).

The ability to acquire and use a language within the acceptable standards of a society takes place mostly by accident. Very little formal training is given before meaningful and expressive sentences are used by most children in any community. Such is not the case of most deaf children who grow up in a hearing world void of deaf adults in the home setting. It is because of this dilemma that I have chosen the topic of Artificial Intelligence in language development and/or instruction with the deaf.

In the past 10 to 15 years the use of computers as an educational tool has been been incorporated in serveral areas of teaching the deaf (AAD 1982). The results of this technological use has shown some growth, but it has not been substantial in terms of increased reading and language levels. One of the problems lies in the fact that most of the CAI used has been based on a drill and practice format and there still exists a

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language problem in this presentation model. Gerg P. Kearsley suggests some possible solutions to this dilemma with the use of CAI and A.I. incorporated. Kearsley suggests that the usefulness of A.I. in CAI has two benefits, because of its languages. Then he states , "There is the possibility of replacing the standard keyword-based answer used in almost all traditional CAI languages (e.g. COURSEWRITER, TUTOR, CAN) with a 'real' analysis based on meaning."

He further explains this idea when he writes that A.I. systems are based on knowledge representation and this changes the interactive responses for the user. One statement by Keasley may clarify this better. "Suffice it to say here that the availability of such a knowledge base permits the CAI system to 'understand' what it is teaching, to build a model of tne student's state of understanding, and to identify deficiencies in its own understanding of a subject." Although many experts would agree with the idea Keasley presents, in terms of gaining knowledge from the student, the need for an A.I. system to interpret input from a student with understanding is very critical if the desired results are going to occur.

It is this difficult area of receiving and understanding new information that inhibits the deaf as well as an A.I. system. I think this point is made clear in an article by Linguet-Higgins (1971) when he writes:

> Broadly speaking there are two kinds of problems in artificial intelligence-'ideal'and 'real';and the 'real' problems are the really difficult ones. Typical 'ideal' problems are the writing of game-playing

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> programs, the discovery of 'heuristic' procedures for solving mathematical problems of various kinds and the construction of routines for searching logical networks.They have the common feature of the universe to which they relate can be fully described by the programmer, who can also specify the manner in which the problem is to be represented inside the computer. By 'real' problems I mean those that confront one in the noisy, squashy, untidy, fragile, unpredictable world outside the computer room. The world in which human beings operate with remarkable success-their success being even more remarkable when one tries to think how they achieve it.

Though this article is more than ten years old, it is obvious that real problems for A.I. systems still exist and such problems are the dilemma of a "real" language based A.I. system. Longuet-Higgins closes his article by writing, "It is one thing to write general-purpose planning programs in which the 'states' of the problem are merely nodes on an abstract graph; it is quite another to take the a 'real life' problem in the form in which it is actually presented-as a visual,auditory or tactile input- and transform it into abstract representation upon which a planning program can then start work." Here again is the task which faces an A.I. system which is attempting to interpret natural language and its meaning.

It is the intent of an A.I. program to interpret what information it receives and respond with the most appropriate answer it can produce. This is done in a number of different techniques and approaches depending on the programmer and the design used to complete the task. These techniques are known as translation processes. Here is a list of four of these processes: lexical analysis (and dictionary-lookup), syntax

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analysis(also called parsing),semantic processing and discourse. This list is taken from Gloess (1981). Since a important part of this paper is to look at the language usage of the deaf with A.I.,(which obviously deals with syntactical structures), an article that deals specifically with the parsing of a sentence using an A.I. approach will be mention later in this paper. Also, discussed in this paper will be some reasons why this type of A.I. technique may be hard to use with the syntactical structure of the deaf.

In an overview paper by Mitchell Marcus (Marcus 1979), Marcus describes several problems and some new solutions for parsing a sentence using an explanatory method as opposed to a descriptive theory. The topic of his paper points out several problems that exist when a computer is programmed to interpret a sentence without "looking ahead" to see what speech parts each word will be labeled, before the sentence has been fully read. This term "looking ahead" means attaching morphological properties which are appropriate to the structure of the sentence. This is obviously very important if the program is going to accurately use the input for a meaningful product in the execution of the task.

Marcus' paper goes into great detail on how sentences can be broken into parts and read by a grammar interpreter of the program. His emphasis here is that a buffer is provided so the word will receive the correct speech part after the sentence has been viewed. Marcus states this more clearly when he writes,"It is impossible to distinguish between [a] pair of sentences before examining the morphology of the verb following [a] Noun

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Phrase. [A] sentence can be distinguished, however, if the parser has a large enough 'window' on the clause to see [a] clause." One of the main points of his paper is that current programs are not built to distinguish the difference mentioned aboved because they do not incorporate the qualities that Marcus believes are essential for an Artificial Intelligence to have the capabilities it needs to perform these tasks.

Although the design mentioned above makes many efforts to solve some of the current problems in A.I. techniques there are still some problems that are not addressed when A.I. designers consider the syntactical structures of the deaf. Paul Arnold (1981) writes, "If it were the case that the word order of English sentences was absolutely rigid or if it were quite optional, then it would be quite easy for the deaf child to learn to use English." Arnold, being aware of the problem of deaf language states, "In programming a computer to help teach English to deaf children, any limitation or success will depend on the adequacy of the programmers' understanding of the nature of the English language, of language learning and language teaching, and the problems of the deaf child in these areas."

One of the first systems developed incorporating the techniques of Artificial Intelligence to help the deaf in the area of language development and usage was a system designed by Madelin Bates and Kirk Wilson. The name of this system is ILIAD. In a telephone conversation I had with Madeleine Bates (of Bolt Beranek and Newman Inc.) she described the main points of the system.

This system was designed to provide a variety of language

skills with specific attention given to recognizing correct sentence structures and making changes if the sentences were incorrect. The format of the system was tutorial, presenting the student material relating to a single topic. Also, each tutorial was designed to work on an individual student need. The techniques of Artificial Intelligence were used to generate new sentences as the students used the program to master a specific exercise. This ability to generate new sentences allowed the user the opportunity to receive numerous and new examples, ranging from simple to very complex sentences.

The funds for this project were provided from the Bureau of Education for Handicapped Children. This project received funding from 1979 to 1981. In 1981 Kirk Wilson started his own company, The Learning Tool, which was involved in designing a limited number of educational software packages. Madelin Bates has not continued to work in this area since 1981, though she still has an interest in it.

Another person who has an interest in meeting the language needs of the deaf with the use of Artificial Intelligence is Robert Ward from the University of Hull in England. Robert Ward attempted to meet these needs by designing a system which would use A.I. techniques and some input from the deaf user of the system (See Appendix II). Ward designed his program after a program named JUMBLE. JUMBLE was mainly a program that required the user to unscramble words from a sentence presented by the program. The following is a description of Ward's program taken from Arnold and Ward (1982):

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> Ward has attempted to develop the JUMBLE approach by incorporating more sophisticated linguistic processing. The computer can analyze and give feedback about sentences composed entirely by the pupil. Of course, to be computationally practical the permitted vocabulary and syntax must be limited. Vocabulary is limited to words illustrated by a picture which the pupil's sentence should describe. The syntax is restricted to one general form, e.g. subject-verb-object. However, other syntactic and semantic forms can be used with the central analysis and feedback program. The system has been designed to enable teachers to construct their own 'dictionary' and syntax files so that the program uses the teachers' own material.

As I began this paper and thought how an A.I. system could work with the language of the deaf, I considered a system similar to the one described by Ward. Any system designed to interpret language would need to receive additional information from the user if it is going to be meaningful to the program's execution. Again this is particularly important with the deaf because of their lack of mastery of the English language. Longuet-Higgins (1971), mentions when he writes, "One rediscovers, in fact what the phoneticians and linguists have known for some time now, namely that we could never hope to understand what is said to us unless we were able to use contextual intonational, syntactical and semantic clues for decoding the actual sounds themselves." As this process continues to develop in A.I., I hope further programs for the deaf will be designed.

One system that is attempting to address the problems just mentioned is a system by Steve Small (1981) which he calls the Word Expert Parser WEP. This program analyzes parts of natural language in the text so as to gain a meaning in context. Small

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states that,"The theoretical position advanced by WEP about the nature of individual words is that the words have no meaning per se, but rather, that the fragments of lexical items mean something through their interrelationships." He continues his explanation of this when he writes, "Furthermore, the character of the lexical relations runs the gamut from the simple direct knowledge concept, to the more analytical knowledge that particular kinds of lexical sequences often represent certain classes of conceptual notions." It is quite clear that Steve Small has a knowledgeable understanding of language which is very important, as mentioned earlier by Ward.

The availability this type of system could be very beneficial when working with the language of the deaf. It will be interesting to see if someone tries to incorporate it into a language development program. This type of system could be used to direct the student to specific areas of instruction and would not continue using drill and practice as other systems mentioned earlier. If a machine can interact with the input of a student and lead the student to applicable areas of instruction, by providing practical examples for practice, then the system would surely be considered intelligent and more than helpful.

In an article by Wilson and Bates (1981), there is a description of what they consider a good intelligent system, "Most intelligent systems have some understanding of the material being taught,some ability to interact with and help a student at the student's level ,some approximate model of the student's thought processes, some ability to answer questions as well as ask them, and/or procedures to determine appropriate

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teaching strategies for a variety of situations." If these types of qualities exist in a system then it will definitely meet many of the educational needs of hearing impaired students.

Wilson and Bates suggest another area of great potential for application of Artificial Intelligence in the area of synthesized speech. They mention the capability of the machine producing speech specially programmed to a student's speech reception and residual hearing for speech frequencies. An additional portion of the machine could produce a sign presentation of the material being stated in the language program. I believe that this could be useful if it is programmed into the machine, but the use of graphics might not clearly communicate the message to the reader. It would be more interesting if a video disc system with a Sign Language dictionary could be attached to the program. If direction were not understood in the printed portion, the user could request that a signed message of the same be provided.

In closing this paper I would like to mention two important areas I believe a sophisticated Artificial Intelligence system should include if the deaf are to benefit from its usage. The first element should include the ability to provide on level language instruction to the user with branching that would incorporate meaningful and appropriate instruction. Secondly give the user feedback when students write sentences which could point out improper sentence structures and usage. There are of course other areas which should also be included, but I think these are the most significant ones.

This paper has provided some new ideas concerning

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Artificial Intelligence and possible solutions to the deficiency of language acquisition and usage for the deaf. I plan to continue researching this area as the use of Artificial Intelligence seems to promise some definite answers to these problems. It is my hope that this technology will make a significant contribution to the study of language development and the specific needs of the deaf. If this does take place, I am sure the next 160 years of educating the deaf will produce much higher results.

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Appendix I

This should be hand written language samples of deaf children. I did not have access to any samples at the time this appendix was printed.

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Appendix II

This is an Example of Robert Ward's System:

1. Deaf Child: Old man STING in a red chair

   Computer: I do not know the word "STING"
   Do you mean "SITTING" Y/N?
   Deaf Child: Y.

2. Deaf Child: OLD man SITTING IS on a red chair

   Computer: Good BUT
   "...OLD" Word missing???
   "SITTING IS" Wrong order???

   Please try again.

3. Deaf Child: The old man is sitting in a RED chair.

   Computer: Good BUT
   The chair is not "RED"
   Try again.

4. Deaf Child: The chair is BLUE
   Computer: Well done!!!

5. Deaf Child: THE OLD MAN IS SITTING IN A BLUE CHAIR

   Computer: Well done!!!

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